541-231

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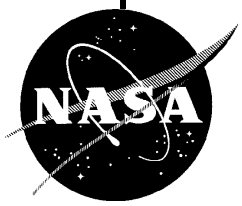
NASA Communications (Nascom) Internet Protocol (IP) Transition Data Format Document

January 1997



National Aeronautics and Space Administration

Goddard Space Flight Center
Greenbelt, Maryland

NASA Communications (Nascom) Internet Protocol (IP) Transition Data Format Document

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Preface

The NASA Communications Division (Nascom) is transitioning from a 4800-bit block protocol to an Internet Protocol (IP) for its network services. Nascom is modifying the WSC and JSC MDMs to provide an IP interface and is building serial/IP Conversion Devices (CD) for serial users to enable them to use the IP network. This document focuses on the IP data formats, mapping tables, and algorithms which must be utilized by the MDMs, the Nascom CDs, and the CDs built by users to maintain end to end communications over the Nascom IP network during the IP transition.

This document is under configuration control, and the Nascom Division Configuration Control Board (CCB) is responsible for processing all changes to it.

Changes and updates to this document will be issued by Documentation Change Notice (DCN) or, where applicable, by complete revision. Questions concerning this document and proposed changes shall be addressed to:

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Change Information Page

List of Effective Pages	
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Title	Original
iii through ix	Updated
1-1 through 1-10	Updated
2-1 through 2-3	Updated
3-1 through 3-16	Updated
Appendix A-1 through A-5	Updated
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Section 1. Nascom IP Data Formats

1.1 Introduction

The intent of this document is to provide, at a high level, the data formats and the mapping tables that will be used within the different systems that are involved with the Nascom Internet Protocol (IP) Transition. This document can be used as a reference for end users who are providing their own encapsulation/de-encapsulation functions and for anyone intending to use the Nascom IP Network.

The Multiplexer/Demultiplexer (MDM), Message Switching System (MSS), and Conversion Devices (CD) are all involved in the Nascom IP Transition plan. The aggregate side of the MDMs at WSC and JSC will be modified to provide an IP interface. The CDs will provide data encapsulation/de-encapsulation functions to allow serial users access to the Nascom IP network including current users of the GSFC and MSFC MDMs. The MSS itself will not be modified although updates by operations to the MSS table will be necessary as MSS users transition to the IP network.

The goal of the Nascom IP Transition is to transition all current Nascom circuits from dedicated point-to-point serial bit-stream or serial blocked data lines to an IP infrastructure using the User Datagram Protocol (UDP).

The MSS will be front-ended with CDs while current Nascom users transition to an IP solution. The planned starting date for this transition is August 1996. By March 1997, both the CDs being used to front-end the MSS and the MSS system will be removed from service. The MDM systems at GSFC and MSFC are scheduled to be removed later in 1997. The CDs installed for end users will continue to be used until all 4800BB end users are doing their own encapsulation.

This document is applicable for as long as 4800-bit blocks (BBs) are used within the Nascom network (either as blocked serial data or as encapsulated data within IP packets).

This document is intended only to show the data formats that the various Nascom systems will use, and to show the network manageable mapping tables within the MDM and CDs. Information about mapping and configuration table management is available in the *Nascom Internet Protocol (IP) Transition Operations Concept Document.*

Current or future users of the Nascom network, including those who are providing an encapsulation/de-encapsulation function to communicate with the Nascom IP network, must be in compliance with the following :

- All data must be in the form of a Nascom 4800-bit block (see Section 1.2) encapsulated within a UDP (*RFC 768*) datagram (see Section 1.3.2) which is, in turn, embedded within an IP (*RFC 791*) datagram (see Section 1.3.1)
- The real-time transport protocol (RTP) (*RFC 1889*) header will be used, primarily for the sequence count capability associated with RTP. The RTP header is embedded within the data portion of the UDP datagram before the 4800-BB (see Section 1.3.3)
- Users must support Internet Group Management Protocol (IGMP) (*RFC 1112*) for multicasting using Class D addressing (see Section 1.4)
- Users must be able to format and transmit Circuit Assurance Blocks (CABs) as required when communicating with a DEMUX device (see Section 1.5)
- Users communicating with MDM devices must support the data processing options required by the MUX or DEMUX device for a specific service, such as clock tracking and CAB enable (see Sections 1.5 and 3)
- IP address assignment and multicasting group registrations must be done through Nascom (see Section 1.6)
- All configuration and mapping tables exchanged between the MDMs and CDs and the Network Management System (NMS) must comply with the formats described in Sections 3 and Appendix A.

1.2 Nascom 4800-bit Block Format

The block format definitions for the Nascom 4800-bit blocks and the Nascom TDRSS 4800-bit blocks are unchanged. Refer to the *Nascom Interface Standard for Digital Data Transmission, 542-003,* Section 3, for complete specifications.

Users doing their own encapsulation must be aware that since the MDMs at GSFC and MSFC are being removed, data rates and other configurable options previously handled by the ITUs on these MUX devices are now the responsibility of the Conversion Devices when sending forward link data. Circuit Assurance Blocks (CABs) are addressed in Section 1.5. The port/block sequence count functionalities are handled by RTP.

Destination codes within the network header of the Message Switching format 4800-bit block are used to map MSS user data to a destination IP address and destination UDP port number. Routing of MDM 4800-bit blocks is based on a mapping of MDM logical port addresses to destination IP addresses and UDP ports (refer to Section 3 for details on 4800-bit block routing).

1.3 IP, UDP and RTP Formats

The following are excerpts from the related RFCs for IP, UDP and RTP. No attempt is made here to include all the information contained in the RFCs. Users are encouraged to obtain their own complete copies of these documents.

1.3.1 The IP Header

Internet Header Format

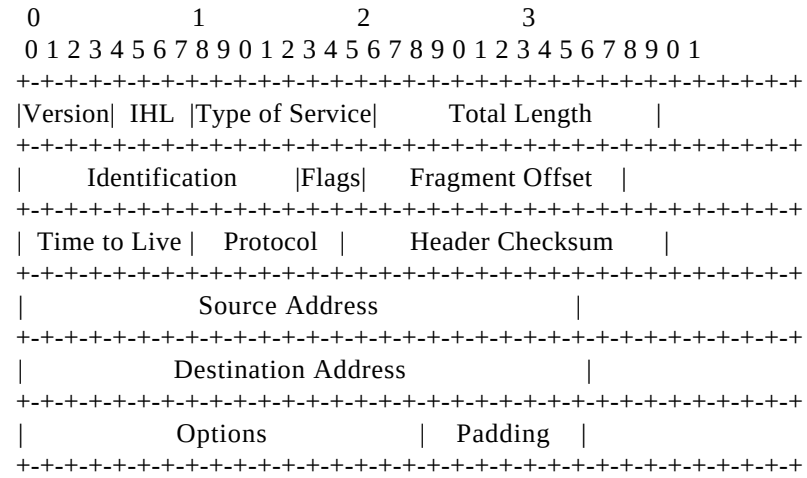

Figure 1-1 IP Header

A summary of the contents of the internet header follows:

Version (4 bits): The Version field indicates the format of the internet header. This value should indicate a decimal value of 4.

IHL (4 bits): Internet Header Length is the length of the internet header in 32 bit words, and thus points to the beginning of the data. Note that the minimum value for a correct header is 5. NOTE: Nascom will have this value set to a decimal value of 5 which means that the IP options are not to be used when transferring encapsulated 4800-BBs through the Nascom IP network.

Type of Service (8 bits): The Type of Service field provides an indication of the abstract parameters of the quality of service desired. These parameters are to be used to guide the selection of the actual service parameters when transmitting a datagram through a particular network.

NOTE: These bits will be set to zero. If Nascom determines that one of the four TOS bits (delay, throughput, reliability, and cost) needs to be set to improve reliabilty of some data streams Nascom will distribute the updated information.

Total Length (16 bits): Total Length is the length of the datagram, measured in octets, including internet header and data. This field allows the length of a datagram to be up to 65,535 octets. Such long datagrams are impractical for most hosts and networks. All hosts must be prepared to accept datagrams of up to 576 octets (whether they arrive whole or in fragments). It is recommended that hosts only send datagrams larger than 576 octets if they have assurance that the destination is prepared to accept the larger datagrams.
NOTE: For encapsulated 4800-BBs to be transferred through the Nascom IP network, this value must be set to a decimal value of 640 (20 octets for the IP header + 8 octets for UDP header + 12 octets for RTP header + 600 octets for 4800-bit block structure).

Identification (16 bits): An identifying value assigned by the sender to aid in assembling the fragments of a datagram.
NOTE: This is an IP layer field not accessed by users.

Flags (3 bits): Various Control Flags.
Bit 0: reserved, must be zero
Bit 1: (DF) 0 = May Fragment, 1 = Don't Fragment.
Bit 2: (MF) 0 = Last Fragment, 1 = More Fragments.

Fragment Offset (13 bits): This field indicates where in the datagram this fragment belongs. The fragment offset is measured in units of 8 octets (64 bits). The first fragment has offset zero.

Time to Live (8 bits):
This field indicates the maximum time the datagram is allowed to remain in the internet system. If this field contains the value zero, then the datagram must be destroyed. This field is modified in internet header processing. The time is measured in units of seconds, but since every module that

processes a datagram must decrease the TTL by at least one even if it processes the datagram in less than a second, the TTL must be thought of only as an upper bound on the time a datagram may exist. The intention is to cause undeliverable datagrams to be discarded, and to bound the maximum datagram lifetime. NOTE: For transferring multicast data within the Nascom IP network, this value must be set to at least 10. This value is under review by Nascom. When a final value is determined, this document will be updated.

Protocol (8 bits): This field indicates the next level protocol used in the data portion of the internet datagram.
NOTE: For encapsulated 4800-BBs this field must be a decimal value of 17.

Header Checksum (16 bits): A checksum on the header only. Since some header fields change (e.g., time to live), this is recomputed and verified at each point that the internet header is processed.
CHECKSUM ALGORITHM: The checksum field is the 16 bit one's complement of the one's complement sum of all 16 bit words in the header. For purposes of computing the checksum, the value of the checksum field is zero. This is a simple way to compute checksum and experimental evidence indicates it is adequate, but it is provisional and may be replaced by a CRC procedure, depending on further experience.

Source Address (32 bits): The source address. See section 3.2 of RFC 791 NOTE: For encapsulated 4800-BBs, this field would contain a Class-B, unicast, address.

Destination Address (32 bits): The destination address. See section 3.2 of RFC 791 NOTE: For encapsulated 4800-BBs, this field would contain either a Class D multicast address or a Class B unicast address.

Options (variable number of bits): The options may or may not appear in datagrams. They must be implemented by all IP modules (host and gateways). What is optional is their

transmission in any particular datagram, not their implementation. NOTE: For encapsulated 4800-BBs, options are not used and should not be present within the IP header. The IP header length will be the standard 20 bytes.

Padding (variable number of bits): The internet header padding is used to ensure that the internet header ends on a 32 bit boundary NOTE: There is no padding for encapsulated 4800-bit blocks.

1.3.2 The UDP Header

The UDP header has the following format:

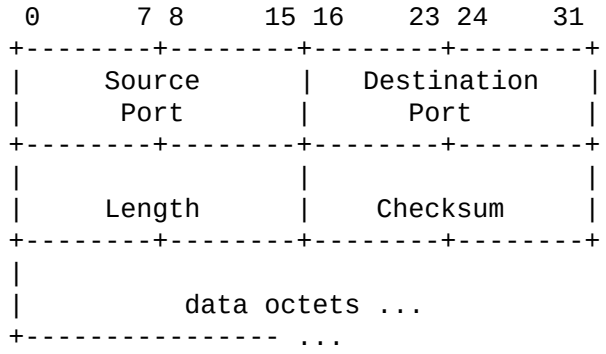

Figure 1-2 UDP Datagram Header

A summary of the contents of the UDP header follows:

Source Port (16 bits): Indicates the port of the sending process. NOTE: For encapsulated 4800-BBs, this field contains the UDP port of the sending device (CD, MDM, or host). This field is not used by any Nascom mapping tables.

Destination Port (16 bits): This field has a meaning within the context of a particular internet destination address. NOTE: For encapsulated 4800-BBs, this field contains the UDP port of the destination device. This field is used in mapping tables used by Nascom and its value will be assigned by Nascom.

Length (8 bits): This is the length in octets of this user datagram including this header and the data. (This means the minimum value of the length is eight.) NOTE: For encapsulated 4800-BBs, this field shall have a decimal value of 620.

Checksum (16 bits): This is the 16-bit one's complement of the one's complement sum of a pseudo header of information from the IP header, the UDP header, and the data, padded with zero

octets at the end (if necessary) to make a multiple of two octets.

NOTE: The use of a UDP checksum is optional. The routers and conversion devices in the Nascom network will employ UDP checksum.

1.3.3 The RTP Header

The RTP header has the following format:

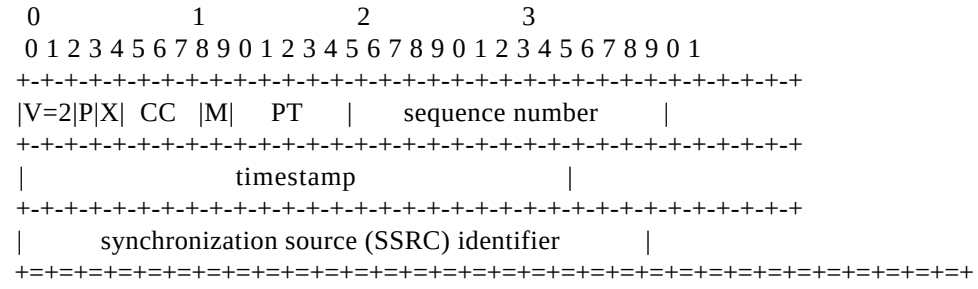

Figure 1-3 RTP Header

A summary of the contents of the RTP header follows:

version (V) (2 bits): This field identifies the version of RTP.

NOTE: For encapsulated 4800-BBs, this field shall have a decimal value of 2.

padding (P) (1 bit): If the padding bit is set, the packet contains one or more additional padding octets at the end which are not part of the payload. The last octet of the padding contains a count of how many padding octets should be ignored. Padding may be needed by some encryption algorithms with fixed block sizes or for carrying several RTP packets in a lower-layer protocol data unit. NOTE: For encapsulated 4800-BBs, this field shall be set to zero.

extension (X) (1 bit): If the extension bit is set, the fixed header is followed by exactly one header extension, with a format as defined in RFC 1889, Section 5.3.1. NOTE: For encapsulated 4800-BBs, this field shall be set to zero.

CSRC count (CC) (4 bits): The CSRC count contains the number of CSRC identifiers that follow the fixed header.
NOTE: For encapsulated 4800-BBs, this field shall be set to zero.

marker (M) (1 bit): The interpretation of the marker is defined by a profile. It is intended to allow significant events such as frame boundaries to be marked in the packet stream. A profile may define additional marker bits or specify that there is no marker bit by changing the number of bits in the payload type field (see RFC 1889, Section 5.3).
NOTE: For encapsulated 4800-BBs, this field shall be set to zero.

payload type (PT) (7 bits): This field identifies the format of the RTP payload and determines its interpretation by the application. A profile specifies a default static mapping of payload type codes to payload formats. Additional payload type codes may be defined dynamically through non-RTP means. An initial set of default mappings for audio and video is specified in the companion profile Internet-Draft draft-ietf-avt-profile, and may be extended in future editions of the Assigned Numbers RFC. An RTP sender emits a single RTP payload type at any given time; this field is not intended for multiplexing separate media streams (see RFC 1889, Section 5.2).
NOTE: For encapsulated 4800-BBs, this field shall initially be set to zero. Nascom is defining a profile to describe the different payload types that Nascom will use for encapsulated 4800-BBs and will provide that information when it becomes available.

sequence number (16 bits): The sequence number increments by one for each RTP data packet sent, and may be used by the receiver to detect packet loss and to restore packet sequence. The initial value of the sequence number is random (unpredictable) to make known-plaintext attacks on encryption more difficult, even if the source itself does not encrypt, because the packets may flow through a translator that does.
NOTE: This field is to be utilized by users of the Nascom IP network to ensure against dropped, out of sequence, or duplicate UDP packets. A sequence error is produced

whenever the sequence number of an incoming packet does not match the expected value. In the case of a sequence number higher than expected the packet is passed on and the expected sequence number value is incremented to one plus the value contained in the packet just received. In the case of a sequence number lower than expected the packet is either passed on or dropped according to the setting of the sequence error drop option in the CD configuration file and the expected sequence number value is not changed. A difference of plus or minus 100 from the expected value results in a sequence error but the packet is always passed.

timestamp (32 bits): The timestamp reflects the sampling instant of the first octet in the RTP data packet. The sampling instant must be derived from a clock that increments monotonically and linearly in time to allow synchronization and jitter calculations. The resolution of the clock must be sufficient for the desired synchronization accuracy and for measuring packet arrival jitter (one tick per video frame is typically not sufficient). The clock frequency is dependent on the format of data carried as payload and is specified statically in the profile or payload format specification that defines the format, or may be specified dynamically for payload formats defined through non-RTP means. If RTP packets are generated periodically, the nominal sampling instant as determined from the sampling clock is to be used, not a reading of the system clock. The initial value of the timestamp is random, as for the sequence number. Several consecutive RTP packets may have equal timestamps if they are (logically) generated at once, e.g., belong to the same video frame. Consecutive RTP packets may contain timestamps that are not monotonic if the data is not transmitted in the order it was sampled, as in the case of MPEG interpolated video frames. (The sequence numbers of the packets as transmitted will still be monotonic).
NOTE: For encapsulated 4800-BBs, this field shall be set to zero.

SSRC (32 bits): The SSRC field identifies the synchronization source. This identifier is chosen randomly, with the intent that no two synchronization sources within the same RTP session

will have the same SSRC identifier. If a source changes its source transport address, it must also choose a new SSRC identifier to avoid being interpreted as a looped source.
NOTE: Not planned for use on Nascom IP network..

1.4 IGMP

IGMP is used in IP multicasting to communicate group membership information among hosts and routers on the network. IGMP provides the protocol that allows a host to join or leave a multicast group and must be supported on any machine that needs to support Class D multicasting. Table 1.1 identifies some of the major hardware platforms and operating systems known to support IGMP ("patch" indicates a software patch needs to be installed).

Hardware	OS	IGMP Support
DEC 5000	Ultrix 4.2, 4.3, 4.4	Patch
DEC Alpha	OSF/1 1.3 +	Patch
DEC Alpha	OSF/1 2.0 +	Y
DEC Alpha	VMS 6.2-7.0	Y **
DEC Alpha	NT 3.51	
DEC VAX	VMS5.5-2 - 7.0	Y **
HP 9000/700	HP-UX 9.05	Patch
HP 9000/700	HP-UX 10.0	Y
IBM RS6000	AIX 3.2	Patch
IBM RS6000	AIX 4.1.3	Y
Intel	BSD/386 1.1 +	Y
Intel	FreeBSD 2.1	Y
Intel	Linux 1.1.94+	Y
Intel	Novel UnixWare	N
Intel	OS/2	N
Intel	OS/2/Warp/ TCP3.0	Y
Intel	SCO	Y
Intel	Solaris	Y
Intel	Win 3.1	N
Intel	Win 95	Y
Intel	Win NT 3.51	Y
Macintosh		N
NeXT		N
SGI Indigo	IRIX 5.3	Y
SGI Indy	IRIX 4.0 +	Y Patch
SGI Indy	IRIX 5.3	Y
Sparc	Sun OS 4.1.3	Patch
Sparc	Solaris 2.3+	Y

Table 1-1 IGMP - Platform and O/S Support

** Supplied by third party vendors: DEC TCP/IP (Digital), Multinet (Cisco/TGV), Pathway (Wollongong), TCPware (Process), CMU-Tek (freeware)

1.5 Circuit Assurance Block (CAB) Emulation

Users sending IP encapsulated 4800-bit data packets to the WSC or JSC DEMUXs will have to emulate the CAB functionality of the current MUX devices. During periods of extremely low data rates or when there is no data flow at all the user must send a CAB to the DEMUX such that the DEMUX receives a CAB at a rate of one per second. CABs are generated in the same format as the Nascom TDRSS 4800-bit block but are uniquely identified by setting the data length field to zero and filling the data field with a 11001001 bit pattern

Conversely, users receiving encapsulated blocked 4800-bit data from a WSC or JSC MUX must have the capability of emulating the DEMUXs "CAB enable" option currently available to users receiving blocked data. With "CAB enable" selected, the user is able to receive the CABs. With "CAB enable" turned off, the CABs are discarded and not received by the user.

1.6 Obtaining IP Addresses and Multicast Group Memberships

Users wishing to become a host on the Nascom IP network must obtain a Class B IP address from Nascom. This address is used by the NMS and other hosts on the Nascom network to send unicast IP communications to the addressee.

Users who have an IP connectivity on the Nascom Network and who wish to receive 4800BB data from another user must "join" the Class D multicast group associated with that data. Such requests can be made by the user (by phone, e-mail, or written communications) to the Nascom ComMgr. Refer to the *Nascom IP Transition Operations Concept Document* for more detailed information about procedures for obtaining IP addresses and for joining or leaving a multicast group.

Section 2. Nascom Network Devices

2.1 Multiplexers/DeMultiplexers (MDMs)

With the Nascom IP Transition initiative, data transferred between users and the MDMs located at WSC and JSC must be encapsulated within the IP/UDP data format. The WSC MDMs remain the source of SN return data and the destination of SN forward data. The aggregate output of the MDMs at WSC and JSC will still support the same data rates as they do today (8 Mbps) but the data format will change to support the transfer of data over an IP network. The WSC and JSC MDMs will no longer use the prequel 80 bit link header that is currently added to each 4800 Bit Block (BB).

Data received from the WSC MDM ITU will be blocked by the MDM and then encapsulated within a UDP/IP datagram (Figure 2-1) and sent out over the Nascom IP Network. When an end user expects serial data (unblocked data), the same description applies except that the data must then be unblocked at the destination site. The routing of datagrams is based on the ITU logical port number from which the data was received.

4800-BBs from current users of the MDMs at GSFC address and MSFC must be sent to the WSC or JSC MDM encapsulated within a UDP/IP datagram (Figure 2-1). Either the end user must provide and perform this function, or a Conversion Device (CD) can be supplied to the end user by Nascom. The datagram will be routed to the WSC or JSC MDM based on the OTU logical port number on which the data needs to be output.

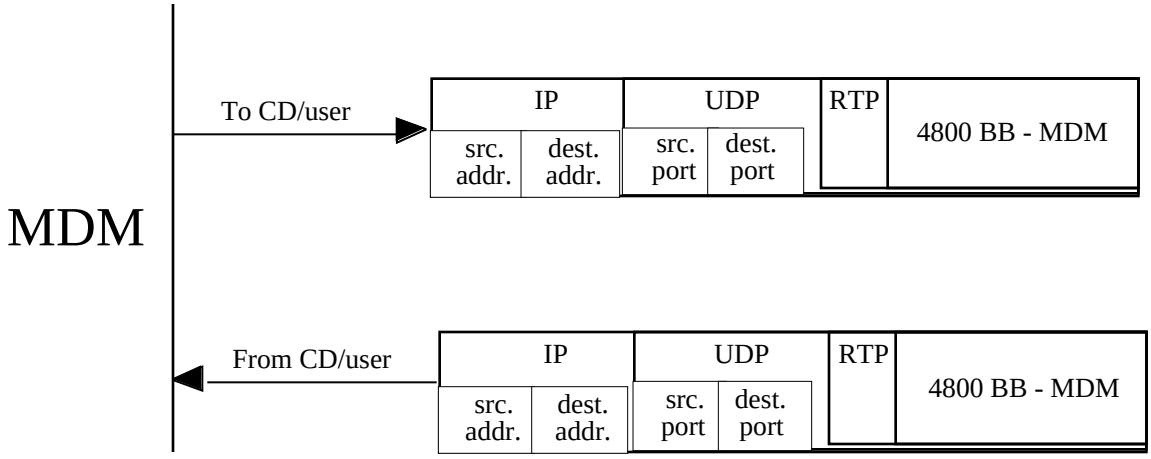

Figure 2-1 MDM Data Formats

2.2 MSS

There are no data format changes required for the MSS (Figure 2-2). A suite of CDs will front-end the MSS to provide the encapsulation/de-encapsulation of 4800-BBs within IP packets.

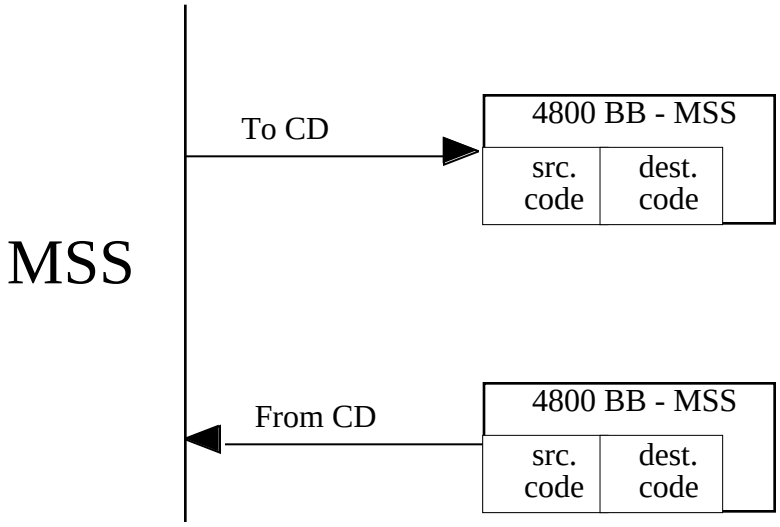

Figure 2-2 MSS Data Formats

The routing table format within the MSS does not change. It uses the destination code to determine the proper physical ports on the MSS to which the data is destined. The following routing table is a general concept of how the MSS routes data to and from end users.

Destination Code	Physical Port
015	468
015	293
074	468
224	631

2.3 Conversion Device (CD)

The CD provides an encapsulation/de-encapsulation function. The CD is configured as a front end to the the user and to the MSS. If an end user has the capability of encapsulating/de-encapsulating 4800-BBs within UDP/IP datagrams, then a Nascom CD is not required. The CD will interface with and be capable of transferring data to and from another CD, the MSS, and the MDM systems in addition to end user's equipment (see Figure 2-3). The different data formats supported and implemented within the CD have been described in the previous sections. On one side of the CD there are serial interfaces sending/receiving 4800-BBs and on the other side of the CD, data is transmitted/received over the Nascom IP network encapsulated within UDP/IP datagrams. There are two types of conversion devices that have been developed by Nascom: the Small Conversion Device (SCD) and the Programmable Telemetry Processor (PTP). Both are rack-mountable PC-based devices but have different operating systems and user interfaces. Refer to the *NASA*

Communications (Nascom) Small Conversion Device (SCD) Operator's Guide and the *Programmable Telemetry Processor (PTP) User's Guide* for more information on the SCD and the PTP, respectively.

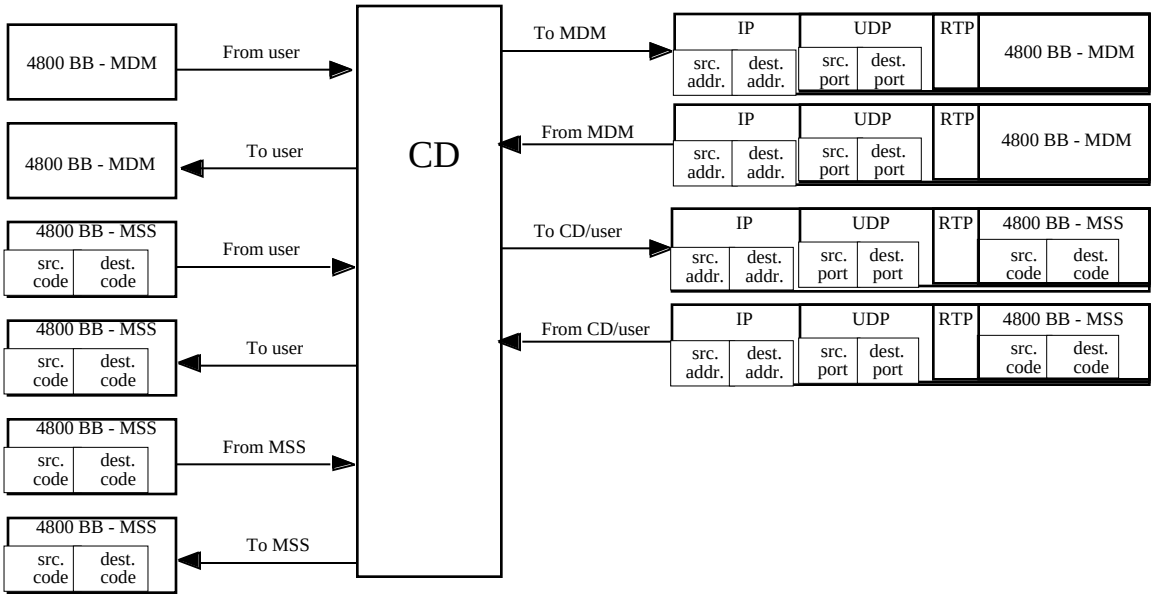

Figure 2-3 CD Data Formats

Section 3. Configuration and Mapping Tables

3.1 Tables Overview

The modified MDM systems at WSC and JSC and the CDs installed throughout the Nascom IP network derive their data routing information and, in the case of CDs, configuration information from tables which are managed by the Network Management System (NMS). To provide ease of management four types of tables have been developed in the form of ASCII text files. The formats are described in Appendix A. The four types are as follows:

CD Configuration Table
MSS Destination Code Table
MUX Table
DEMUX Table

CD Configuration Table:

A CD Configuration Table contains IP to serial and serial to IP mappings (for MDM and patched services), subscribed listen groups, and other information necessary to configure a CD and its serial interfaces. Each CD has a unique CD Configuration Table containing information only for use by that CD. The NMS maintains authoritative versions of all CD Configuration Tables for all the CDs managed by it within the network.

MSS Destination Code Table:

The MSS Destination Code Table maps 4800-BB destination codes to an IP address and UDP port. The NMS and all CDs managed by the NMS have copies of the complete MSS Destination Code Table. If an update is necessary the NMS will distribute the update to all CDs managed within the network.

NOTE: For the duration of the IP transition until the MSS is removed, two different MSS tables must be maintained- one for the MSS FE and one for the remote user CDs. For an explanation of the need for two tables and a description of each, refer to the *Nascom IP Project Transition Plan*

MUX Table:

The MUX Table maps the logical port address of a MUX ITU to an IP address and UDP port. The MUX Table is resident in the modified WSC and JSC MUXs and is managed by the NMS.

DEMUX Table:

The DEMUX Table maps the UDP port received by the DEMUX to the logical port address of a DEMUX OTU and contains a source IP address and a mask field to allow control of which user host(s) are authorized to send to that OTU. The DEMUX Table is resident in the modified WSC and JSC DEMUXs and is managed by the NMS.

3.2 Configuration and Mapping Table Management

The Nascom philosophy for the IP Transition Project is that all table management activity will be performed remotely by the NMS. Changes to conversion device configuration and mapping tables can be initiated from the NMS either by using a combination of Simple Network Management Protocol (SNMP) messages and FTP file transfers, by using telnet to login to a CD, or through the integration of remote control software in the CDs.

The CD operator interface screens for status and configuration modifications are menu driven.

NOTE: It is not necessary to restart a Nascom CD to implement a change to the Configuration Table; changes can be made while the CD is in service. However, for changes which impact a serial interface (e.g. data rate, read/write, or external/internal clock modifications), the serial interface will have to be shut down and restarted. This is an automated function initiated when a table update occurs and takes approximately one second. Only the serial interface being modified is affected by the shutdown/restart.

3.2.1 NMS Monitoring and Management Capabilities

The NMS communicates with conversion devices via FTP, telnet, and SNMP. FTP is to be used to transmit CD Configuration Tables and the MSS Destination Code Table updates between the NMS FTP server and the CD's. Telnet is to be used during early phases of the IP transition to make CD Configuration Table changes to SCDs. Telnet gives the NMS the capability to log in (assuming the SCD's operator and/or administrator account and password is known) to a SCD and view the status screens and, if necessary, use the administrator account to modify the Configuration Table. Remote control software will be integrated into the operating system of PTPs to allow the NMS remote access to the PTP operator interface for configuration purposes.

SNMP is used to provide updates to the MUX and DEMUX mapping tables which are included in the modified MDM MIB(s). SNMP is also used to obtain the status of and, in some cases, set the value of Management Information Base (MIB) status and error condition variables. SNMP messages are also be used to initiate the transfer of table information between the NMS and the CDs (It should be emphasized, however, that the CD configuration tables and the MSS Destination Code Table themselves are not a part of the CD MIBs).

The NMS is capable of the following conversion device control and status functions:

- Update CD tables (both Configuration and MSS tables)
- Request local configuration table from CD
- Monitor CD and MDM status
- Send SNMP messages to CD and MDMs (SETs)
- Receive SNMP traps and GET responses from CD and MDMs

3.2.2 CD Monitoring and Management Capabilities

Monitoring and management capabilities vary depending on the type of conversion device. Each Nascom Small Conversion Device has an operator and an administrator account. The operator account allows operators to view SCD status such as block count totals and out of sequence errors. There are no configuration capabilities associated with the operator account. The administrator account allows an authorized administrator to make configuration changes when necessary, usually done remotely via telnet. Only the NMS will have access to an administrator account on a fully operational CD. Both accounts require a username and password.

The PTPs use a windows-based operator interface which the NMS can access via remote control software built into the PTP. There are no accounts on the PTP's; the PTP operator interface is fully accessible following bootup. Status and error conditions can be obtained via the CD operator interfaces provided that the interface is currently accessed by the NMS. However, each CD's SNMP interface will always provide the NMS with the CD status information documented in the NMS/CD MIB which is returned to the NMS via unsolicited SNMP traps.

A Nascom CD has the following monitoring and configuration capabilities:

- Automated startup using last saved configuration and mapping tables- does not need NMS
- Status monitoring of all tables
- Configuration Table modification
- Download tables from NMS
- Upload tables to NMS
- SNMP trap generation to the NMS for pre-defined critical events (e.g. startup, local configuration change, severe error conditions, etc.)

3.3 CD Configuration Table Description

Scope: one per each CD
Purpose: Provides mapping to indicate which listen groups a serial interface "subscribes" to and contains fields required for CD configuration, some indexed by serial interface as appropriate. Also, for any serial line configured for forward MDM or circuit switch service, this table contains a destination IP address and UDP port.

NOTE: The serial interface is used as an index; the fields that follow the serial interface (e.g. data rate, blocked, etc.) all pertain to that interface. The fields that precede the serial interface field (e.g. CD IP Address, TTL, etc.) pertain to the conversion device as a whole. Refer to the outline below for a representation of this structure.

Fields:

CD Table Version Number
CD IP Address
Multicast Time to Live (TTL)
Primary NMS FTP Server Address
Secondary NMS FTP Server Address
- Serial I/F
  - I/F Presence
  - I/F Status
  - Service Type
  - Data Rate
  - External Clock
  - Read/Write
  - Sequence Error Drop
  - Padding
  - Generate Poly
  - Blocked
  - Port Address
  - Generate CABs
  - CAB Enable
  - CAB Rate
  - Time Tag
  - 1-second Timeout
  - Clock Tracking
  - Clamped Clock
  - Fixed Destination IP Address
  - Fixed Destination UDP Port
  - Listen Groups
  - Receive UDP Port

Description:

CD Table Version Number:
Contains the version number of the CD Configuration Table format. The version number corresponds to a baselined data format which must be known by and compatible with the CD and NMS processes responsible for interpreting the file.

Version numbers will be in the form of two decimal numbers separated by a period (e.g.: 1.0).

Values: Version numbers for the CD Configuration Table will be assigned and managed by Nascom

CD IP Address:

Contains the Class B IP address assigned to the CD. The format is the standard dotted decimal notation for IP addresses comprised of four decimal integers separated by decimal points, where each integer gives the value of one octet of the IP address.

Values: CD IP Addresses are assigned and managed by Nascom

Multicast Time to Live:

This field indicates the time to live value assigned to datagrams originating from a multicast socket on the CD. Possible values range from 5 to 100 decimal.

Values: The Multicast Time to Live value is assigned and managed by Nascom. The default value will be 10.

NMS FTP Primary Server Address:

This field contains the IP address of the primary NMS ftp server. This address is utilized by the CD to obtain Configuration and MSS Destination Code Table updates from the NMS. The format is the standard dotted decimal notation for IP addresses comprised of four decimal integers separated by decimal points, where each integer gives the value of one octet of the IP address.

Values: The primary NMS FTP Server Address is assigned and managed by Nascom which has assigned IP address 150.144.180.45

NMS FTP Secondary Server Address:

This field contains the IP address of the secondary NMS ftp server. This address is utilized by the CD to obtain Configuration and MSS Destination Code Table updates from the NMS when the primary server is unavailable. The format is the standard dotted decimal notation for IP addresses comprised of four decimal integers separated by decimal points, where each integer gives the value of one octet of the IP address.

Values: The secondary NMS FTP Server Address is assigned and managed by Nascom which has assigned IP address 150.144.180.46

Serial I/F:

This field is used to determine which serial interface is designated to receive data from a multicast or unicast source, or to send data to a multicast group or unicast destination.

Values: Values can range from 0 to 15**,** inclusively, but the maximum number of serial interfaces is machine dependent

I/F Presence:

This field is used to determine whether or not the serial line is present on the CD.

Values: present = the interface exists for this CD

not_present = the interface is not present on this CD

I/F Status:

This field is used to determine whether or not a serial interface on a CD is configured to send and/or receive data.

Values:enabled = interface is configured for I/O
not_enabled = interface is not configured for I/O

Service Type:

This field identifies whether the destination IP address and UDP port for the serial interface is fixed (use the fixed IP address and UDP port indicated for this interface) or must be looked up in the MSS Destination Code Table. Circuit switched services, including MDM services, are fixed while MSS services determine the destination IP address and UDP port based on the destination code.

Values:fixed = use associated fixed IP address and UDP port
table = use MSS Destination Code Table

Data Rate:

This field indicates the data rate (in kilobits per second) configured for the associated serial interface of the CD when the External Clock option has NOT been selected. Any required data rates which can not be supported internally by a CD must be supplied externally.

Values:Data rates on Nascom circuits can range from 1.2 to 2400 kilobits per second

External Clock:

This field indicates whether or not an external or internal clock source is applied to the serial interface.

Values:n = use internal CD clocking
y = external clock must be applied

Read/Write:

This field identifies whether the serial interface is configured for reads, writes, or both.

Values:r = interface is configured only for serial READ (simplex)
w = interface is configured only for serial WRITE (simplex)
rw = interface is configured for BOTH serial read and write (duplex)

Sequence Error Drop:

This field indicates whether the CD is to forward or discard blocks detected as out of sequence.

Values:drop = discard block
pass = forward block

Padding:

This field indicates the amount of padding in bytes inserted between 4800-bit blocks transmitted on the associated interface of the CD. The default is 0 bytes.

Values:Byte padding can range from 0 to 28 bytes in increments of 1 byte

Generate Poly:

This field indicates whether or not the CD is to generate a polynomial checksum on the data.

Values:y = generate poly
n = do not generate poly

Blocked:

This field indicates whether the interface is configured for blocked or unblocked data.

Values:y = blocked
n = unblocked

Port Address:

This field provides, by means of four hexadecimal digits, the logical port address of the OTU at the WSC or JSC MDM for CD serial interfaces configured for fixed MDM-type service. This field is informational only and is not used for routing. This field is applicable only for serial interfaces which are configured for MDM (fixed) service.

Values:Logical port addresses are assigned and maintained by Nascom

Generate CABs:

This field indicates whether or not an interface configured for fixed service generates a Circuit Assurance Block at the rate specified by the CAB Rate field (below). This field will be ignored for serial interfaces which are configured for MSS (table) service.

Values:y = generate CABs
n = do not generate CABs

CAB Enable:

This field indicates whether or not Circuit Assurance Blocks are to be passed through to the user application or discarded. This field will be ignored for interfaces configured for MSS (table) service or unblocked MDM (fixed) data.

Values:y = pass CABs on to user
n = discard CABs

CAB Rate:

This field indicates in milliseconds how often a Circuit Assurance Block is to be generated to the DEMUX for the associated serial interface of the CD if the interface is configured for unblocked MDM (fixed) data. This field will be ignored for serial interfaces which are configured for MSS (table) service or non-MDM fixed service.

Values:CAB rates can range from 0 to 1000 ms in increments of 1 ms

Time Tag:

This field indicates whether or not, for a serial interface configured to support MDM (fixed) service for blocked data, the CD is to insert its own clock time (GMT) into the 4800-bit block header or leave the clock time placed in the header by the user. This field will be ignored for interfaces which are configured for MSS (table) service or non-MDM fixed service.

Values:y = CD inserts GMT time tag into header
n = no time tag inserted by CD

One-second Timeout:

This option is applicable only when the interface is configured to transmit unblocked MDM (fixed) data. An interface configured for the one-second timeout option will insert fill bits and send out a block if the data rate is too slow to fill in all 4624 bits of the data field within one second. If the one-second timeout option is enabled the transmission of CABs must be disabled.

Values:y = one-second timeout option enabled

n = one-second timeout option disabled

Clock Tracking:

This option is applicable only when the interface is configured to receive unblocked MDM (fixed) data. An interface configured for clock tracking will synchronize its output clock with its input clock to avoid buffer underflow/overflow.

Values:y = clock tracking enabled
n = clock tracking disabled

Clamped Clock:

This option is applicable only when the interface is configured to receive unblocked MDM (fixed) data. An interface configured for clamped clock will clamp the clock signal to a logical 1 during periods when no data is being processed whereas an unclamped clock will remain set at the specified data rate regardless if data is present.

Values:y = clamped clock
n = unclamped clock

Fixed Destination IP Address:

This field contains the IP address of the target host when the interface is configured for fixed (MDM or non-MDM circuit switched) service and can be either a unicast or multicast address. For CD interfaces configured for transmitting IP messages to the MDMs at WSC or JSC this field will contain the multicast IP address associated with the WSC or JSC DEMUXs. The format is the standard dotted decimal notation for IP addresses comprised of four decimal integers separated by decimal points, where each integer gives the value of one octet of the IP address. This field is ignored if the serial interface is configured for MSS (table) service.

Value: Fixed Destination IP Addresses are assigned and managed by Nascom

Fixed Destination UDP Port:

This field contains the UDP port that the data is destined for on the target host when the interface is configured for fixed (MDM or non-MDM circuit switched) service. For CD interfaces configured for transmitting IP messages to the MDMs at WSC or JSC this field will contain the destination UDP port associated with the WSC or JSC DEMUX. Possible values range between 1,025 and 65,535 decimal. This field is ignored if the serial interface is configured for MSS (table) service.

Values: Fixed Destination UDP Port numbers are assigned and managed by Nascom

Listen Groups:

This is a sub-table containing a list of IP addresses(multicast Class D or unicast) to which the corresponding serial interface "subscribes." The format is the standard dotted decimal notation for IP addresses comprised of four decimal integers separated by decimal points, where each integer gives the value of one octet of the IP address. The number of listen groups allowed per serial interface can range from 0 to 255 but the maximum value is machine dependent and is equal to the number of open file descriptors supported by the hardware platform. For serial interfaces configured for read only this field is ignored.

Values: Multicast addresses are assigned and managed by Nascom

UDP Receive Port:

This is a sub-table which lists a corresponding CD UDP receive port for each multicast group in the Listen Group sub-table. Possible values for UDP port numbers can range from 1025 to 65,535 decimal when a corresponding listen group is specified and ignored otherwise.

Values: UDP port numbers are assigned and managed by Nascom. UDP port numbers for multicast addresses contained within the MSS Destination Code Table are all assigned the value 8001.

Figure 3-1 is a conceptual representation of the CD Configuration Table example broken into sections for readability. Refer to Appendix A for an example of the actual ASCII text file format:

Version No.	CD IP Address	TTL	Prime Server IP Addr	Sec Server IP Addr	Ser I/F	I/F Prs	I/F Status
1.0	150.144.180.21	10	150.144.180.45	150.144.180.46	1	y	enabled
					2	y	enabled
					3	y	enabled

Serv Type	Data Rate	Ext Clk	R/W	Seq Err Dr	Pad	Gen Ply	Blkd	Port Addr	CAB Gen	CAB En	CAB Rt
table	56	n	rw	drop	0	n	y	0	n	drop	0
table	56	n	rw	pass	0	n	y	0	n	drop	0
fixed	9.6	n	w	pass	0	y	y	0222	n	pass	0

TT	TO	Clk Trk	Clmp Clk	Cktsw	Fixed Dest. IP Addr	Fixed Dest UDP Port	Listen Groups	UDP Port
n	n	n	n	n	0	0	225.0.0.14	8001
n	n	n	n	n	0	0	225.0.0.110	8001
							225.0.0.116	8001
n	n	n	n	n	0	0	225.5.11.202	8202

Figure 3-1 CD Configuration Table Example

3.4 MSS Destination Code Table Description

Scope: all CDs managed by the NMS
Purpose: Used by a CD to map the destination code of a serial data block from/to MSS user to destination IP address.
Fields:

Destination Code Table Version Number
MSS Destination Code
Destination IP Address

Destination UDP Port

Description:

Destination Code Table Version Number:

Contains the version number of the Destination Code Table. The version number corresponds to a baselined data format which must be known by and compatible with the CD and NMS processes responsible for interpreting the file. Version numbers will be in the form of two decimal digits separated by a period (e.g.: 1.0).

Values: Version numbers for the Destination Code Table will be assigned and managed by Nascom

Destination Code:

Contains a valid MSS supported destination code.

Values: 1 to 377 octal. Destination codes are assigned and managed by Nascom.

Destination IP Address:

Contains the multicast address of either a single host or group of hosts to which the data is destined. The format is the standard dotted decimal notation for IP addresses comprised of four decimal integers separated by decimal points, where each integer gives the value of one octet of the IP address.

Values: Destination IP addresses are assigned and managed by Nascom

Destination UDP Port:

Contains the UDP port number that the data is to be sent to on the receiving host specified by the Destination IP Address. Possible values for UDP port numbers can range from 1025 to 65,535 decimal.

Values: All Destination UDP Port numbers in the MSS Destination Code Table use 8001.

Figure 3-2 gives a conceptual representation of a part of the MSS Destination Code Table. Refer to Appendix A for an example of the actual ASCII text file format:

Version Number	Dest Code	Destination IP Address	Destination UDP Port
1.0	074	225.0.0.60	8001
	063	225.0.0.51	8001
	215	225.0.0.141	8001
	017	225.0.0.15	8001
	303	225.0.0.195	8001
	032	225.0.0.26	8001

Figure 3-2 MSS Destination Code Table Example

3.5 MUX Table Description

Scope: WSC MUX, JSC MUX
Purpose: Maps the logical port address of the MUX ITU to the destination IP address of the end user (CD).
Fields:
MUX Table Version Number
Site ID
ITU Logical Port Address
Destination IP Address
Destination UDP Port

Description:

MUX Table Version Number:
Contains the version number of the MUX Table. The version number corresponds to a baselined data format which must be known by and compatible with the MUX and NMS processes responsible for interpreting the file. Version numbers will be in the form of two decimal digits separated by a period (e.g 1.0).

Values:Version numbers for the MUX Table will be assigned and managed by Nascom

Site ID:
Identifies whether the device is a WSC or JSC MUX.

Values:wsc = WSC MUX
jsc = JSC MUX

ITU Logical Port Address:
This field provides, by means of four hexadecimal digits, the Logical Port Address(LPA) of the ITU at the WSC or JSC MUX.

Values:Values for this field can range from 1 to FFFF. ITU Logical Port Addresses are assigned and managed by Nascom.

Destination IP Address:
Contains the multicast IP address of either a single host or group of hosts to which the data is destined. The format is the standard dotted decimal notation for IP addresses comprised of four decimal integers separated by decimal points, where each integer gives the value of one octet of the IP address.

Values:Multicast addresses are assigned and managed by Nascom

Destination UDP Port:
This field contains the destination UDP port number on the host(s) to which data is being sent.

Values:UDP port addresses are assigned and managed by Nascom

Figure 3-3 gives a conceptual representation of an example of part of the MUX Table. Refer to Appendix A for an another example.

Version Number	Site ID	logical port address	Destination IP address	Destination UDP Port
1.0	wsc	0112	225.01.01.12	7070
		0054	225.01.00.54	7070
		0213	225.01.02.13	7070
		0194	225.01.01.94	7070

Figure 3-3 MUX Table Example

3.6 DEMUX Table Description

Scope: WSC DEMUX, JSC DEMUX
Purpose: Maps receiving UDP port numbers of DEMUX to logical port address of DEMUX OTU. This table also provides the IP addresses of the sources that are allowed to send to this OTU.

Fields:

DEMUX Table Version Number
Site ID
OTU Logical Port Address
Source IP Address
Source IP Address Mask
Destination UDP Port

Description:

DEMUX Table Version Number:

Contains the version number of the DEMUX Table. The version number corresponds to a baselined data format which must be known by and compatible with the DEMUX and NMS processes responsible for interpreting the file. Version numbers will be in the form of two decimal digits separated by a period (e.g.: 1.0).

Values: Version numbers for the DEMUX Table will be assigned and managed by Nascom

Site ID:

Identifies whether the device is a WSC or JSC DEMUX.

Values: wsc = WSC DEMUX
jsc = JSC DEMUX

OTU Logical Port Address:

This field provides, by means of four hexadecimal digits, the logical port address of the OTU at the WSC MDM.

Values: Values for this field can range from 1 to FFFF. OTU Logical Port Addresses are assigned and managed by the NCC.

Source IP Address:

Contains a Class B unicast host address from which data is allowed to be received on the OTU. The value of this field, when used in conjunction with the Source IP Address Mask, is used by the DEMUX to determine if the data originates from a valid Nascom source for the associated OTU. The format is the standard dotted decimal notation for IP addresses comprised of four decimal integers separated by decimal points, where each integer gives the value of one octet of the IP address.

Values: Unicast addresses and subnets are assigned and managed by Nascom

Source IP Address Mask:

Contains a mask which is applied against the IP address contained in the Source IP Address field to modify the scope of that IP address. The resultant value is used by the DEMUX to determine whether the data originated from a valid source for the associated OTU. The format is the standard dotted decimal notation for IP addresses comprised of four decimal integers separated by decimal points.

Values: Source IP Address Mask values are assigned and managed by Nascom. A value of 0.0.0.0 is interpreted by the DEMUX as meaning that the Source IP Address Mask field should be ignored and that only the value contained in the Source IP Address should be used to determine source validity.

Destination UDP Port:

This field contains the destination UDP port number on the DEMUX on which data is being received.

Values: UDP port addresses are assigned and managed by Nascom

Figure 3-4 gives a conceptual representation of an example of a part of a DEMUX Table. Refer to Appendix A for another example.

Version Number	Site ID	Logical Port Address	Source IP address	Source IP Addr Mask	Destination UDP Port
1.0	wsc	0112	160.155.29.24	255.255.255.255	6112
		0223	171.128.76.30	255.255.255.240	6223
		0107	160.158.83.63	255.255.255.255	6107
		0107	171.134.73.61	255.255.255.240	6107

Figure 3-4 DEMUX Table Example

Appendix A Table Formats

A.1 Table Format Overview

The SCD Configuration Tables and the MSS Destination Code mapping table described in Section 3 are maintained in the form of ASCII text files. The conversion devices and NMS extract the information from the files to perform any required processing on the data. It is these files, in the formats described below, that are exchanged via FTP between the NMS and the conversion devices (MSS Dest Code Table). In addition the SCD Configuration files may be modified via Telnet in order to provide updates initially. Any conversion device managed by the NMS on the Nascom network must conform to these formats. Remote control software integrated into the operating system of PTPs also allows the NMS remote access to the PTP operator interface for configuration purposes.

The MUX and DEMUX mapping tables will be included in the MUX and DEMUX MIB(s). They will be updated only via SNMP. The sample ASCII text format provided below illustrates the format of the fields.

NOTE: The data contained in the tables below are for the purposes of demonstrating the data formats only and are not intended to represent actual operational information.

A.2 Conventions

Users doing their own encapsulation can extract the information from these files in any manner that they deem reliable and efficient (NOTE: A conversion device is responsible for validating any information downloaded from the NMS). In some cases the value of specific fields determines how the file is to be interpreted. For example, an interface configured for MSS service does not reference the fixed destination IP address contained in the configuration table. In this case, the MSS Destination Code Table is referenced.

All of the configuration and mapping tables described below subscribe to the following conventions:

- Any line preceded by two slashes (//) represents a comment
- The type or extent of white space (i.e. tabs vs single space) separating fields is not intended to be interpreted as being significant
- Key words (e.g. ftp_srv, serial_if) at the beginning of some lines of text are used to direct or delimit the interpretation of data contained in the file
- Any information associated with a serial interface with an I/F Presence value of not_present can be ignored

A.3 CD Configuration Table Example

```
//        Conversion Device Configuration Table for stocc-2
//
//        Version - current version of CD configuration file for stocc-2
version 1.0
//
//        CD IP Address
ip        150.144.180.70
//
//        Multicast Time to Live Control
ttl       10
//
//        FTP Prime and Secondary Host servers
ftp_srv   150.144.180.45   150.144.180.46
//
//                                                  Serial I/F #0
//
//              serial    I/F          I/F       service  data  ext  read/  seq err  block  gen
//               I/F   presence     status      type     rate  clk  write   drop     pad   poly
//
serial_if        0    present      enabled     table     56    n     rw      pass     0      n
//
//        If service type is fixed then read following lines
//
//                    port   CAB   CAB    CAB   time  1-sec.   clk    clmp
//        blocked     addr   gen   enable  rate   tag   t.o.    trk    clk
//
             y        0000   n     pass    000    n     n       n      n
//
//        Fixed Destination IP Addr       Fixed Destination UDP Port
fixed_ip    0.0.0.0                          0
//
//
//        Assigned Listen Groups - IP Address and UDP Port
//                  (List starts with mc_start, ends with mc_end)
//
mc_start
225.0.0.63      8001
mc_end
//
//                                                  Serial I/F #1
//
//              serial    I/F          I/F       service  data  ext  read/  seq err  block  gen
//               I/F   presence     status      type     rate  clk  write   drop     pad   poly
//
serial_if        1    present      enabled     table    224    n     rw      pass     0      n
//
//        If service type is fixed then read following lines
//
//                    port   CAB   CAB    CAB   time  1-sec.   clk    clmp
//        blocked     addr   gen   enable  rate   tag   t.o.    trk    clk
//
```

```
            n       0000    n       drop    0       n       n       n       n
//
//      Fixed Destination IP Addr       Fixed Destination UDP Port
fixed_ip    0.0.0.0                             0
//
//      Assigned Multicast Groups - IP Address and UDP Port
//              (List starts with mc_start, ends with mc_end)
//
mc_start
225.0.0.43              8001
mc_end
//
//                                              Serial I/F #2
//
//      NOTE:  This I/F currently not configured
//
serial_if       2       not-present
//
//      end of file for SCD007
```

A.4 MSS Destination Code Table Example

```
//      MSS Front End Destination Code Table
//
//      Version number
version  1.0
//
//      Dest. Code      IP Address          UDP Port
        1               225.0.0.1           8001    //      MILA Tracking
        2               225.0.0.2           8001    //      MIL-71
        3               225.0.0.3           8001    //      MIL-71 DSS-72
        4               225.0.0.4           8001    //      Bermuda Tracking
                                :
                                :
        376             225.0.0.254         8001    //      JPL-TOPEX
        377             225.0.0.255         8001    //      WSC/ETGT
//
//      end MSS Front End Dest Code Table
```

A.5 MUX Table Example

```
//      WSC MUX Table
//
//      Version number
version  1.0
//
site_id   wsc
//
//      Logical Destination             Destination
```

```
//      Port Addr       IP Address          UDP Port
//
        0101            225.1.0.1           4001        //      Description (opt.)
        0102            225.1.0.2           4002        //
        0103            225.1.0.3           4003        //
        0104            225.1.0.4           4004        //
                                :
                                :
        0523            225.1.5.23          4523        //
        0537            225.1.5.37          4537        //
//
//      end WSC MUX Table
```

A.6 DEMUX Table Example

```
//      WSC DEMUX Table
//
//      Version number
version  1.0
//
site_id   wsc
//
//        Logical       Source          Source IP Addr      Destination
//      Port Address    IP Address          Mask            UDP Port
//
        0101            225.2.0.1       255.255.255.240     4001    //  Description (opt.)
        0102            225.2.0.2       255.255.255.255     4002    //
        0103            225.2.0.3       255.255.255.255     4003    //
        0104            225.2.0.4       255.255.255.248     4004    //
                                :
                                :
        0322            225.2.3.22      255.255.255.255     4322    //
        0325            225.2.3.25      255.255.255.240     4325    //
//

//          end WSC DEMUX Table
```

Abbreviations and Acronyms

BB	Bit Blocks
CAB	Circuit Assurance Block
CD	Conversion Device
CRC	Cyclical Redundancy Check
DEMUX	Demultiplexer
FE	MSS Front End (Gateway)
FTP	File Transfer Protocol
GSFC	Goddard Space Flight Center
IGMP	Internet Group Management Protocol
IP	Internet Protocol
ITU	Input Terminal Unit
JSC	Johnson Space Center
MDM	Multiplexer/Demultiplexer
MSFC	Marshall Space Flight Center
MSS	Message Switching System
MUX	Multiplexer
NASA	National Aeronautics and Space Administration
Nascom	NASA Communications Division
NIB	Nascom Interface Board
NMS	Network Management System
NOC	Nascom IP Network Operations Center
OTU	Output Terminal Unit
PA	Port Address
PTP	Programmable Telemetry Processor
RFC	Request For Comment
RTP	Reliable Transport Protocol
SCD	Small Conversion Device

STGT	Second TDRSS Ground Terminal
TDRSS	Tracking and Data Relay Satellite System
UDP	User Datagram Protocol
WSC	White Sands Complex